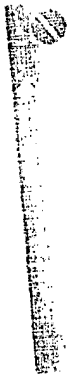
MAT-8117US PATENT

#10/Translation 2/4/03

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Masakazu Hoashi et al. : Art Unit
Serial No.: 09/820,077 : Examiner
Filed: March 28, 2001 :
FOR: DIVERSITY WIRELESS DEVICE AND WIRELESS TERMINAL UNIT



VERIFICATION OF A TRANSLATION

Assistant Commissioner for Patents
Washington, D.C. 20231
SIR :

I, the below named translator, hereby declare that:

1. My name and post office address are as stated below.

2. The document for which the attached English translation is being submitted is a patent application on an invention entitled DIVERSITY WIRELESS DEVICE AND WIRELESS TERMINAL UNIT.

3. That I am knowledgeable in the English language and in the language of JP2000-090367, and I believe the attached English translation to be a true and complete translation of JP2000-090367.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 28 January, 2003

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[NAME OF THE DOCUMENT] Patent Application
[ARRANGEMENT NUMBER] 2913020263
[DATE OF FILING] March 29, 2000
[ADDRESS] Director-General of the Patent Office
[INTERNATIONAL PATENT CLASSIFICATION] H01Q 1/32
[TITLE OF THE INVENTION] Diversity Wireless Device
[NUMBER OF CLAIMS] 5

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[REPRESENTATION OF FEE]
[PAYING METHOD] In-advance payment
[NUMBER IN LEDGER OF IN-ADVANCE PAYMENT] 011305
[AMOUNT] 21000

[LIST OF ARTICLES FILED]
[NAME OF ARTICLE] Specification 1
[NAME OF ARTICLE] Drawing 1
[NAME OF ARTICLE] Abstract 1

[NUMBER OF GENERAL POWER OF ATTORNEY] 9809938

[Name of the Document] Specification

[Title of the Invention] Diversity wireless device

[What is claimed is]

[Claim 1] A diversity wireless device for providing diversity using a plurality of antennas comprising a grounded antenna and an ungrounded antenna.

[Claim 2] The diversity wireless device of claim 1, wherein a ground is placed in proximity to the ungrounded antenna, and is coupled to the ungrounded antenna at high frequency.

[Claim 3] The diversity wireless device of claim 1 or 2, wherein an efficient diversity effect is obtained by manipulating the directivity of the antennas by varying the configuration angle or feed points of the individual antennas.

[Claim 4] A diversity wireless device for providing diversity using a plurality of ungrounded antennas, wherein a ground is placed in proximity to at least one of the ungrounded antennas, and is coupled to the ungrounded antenna at high frequency.

[Claim 5] The diversity wireless device of claim 4, wherein an efficient diversity effect is obtained by manipulating the directivity of the antennas by varying the configuration angle or feed points of the individual antennas.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a diversity wireless device used for wireless communications.

[0002]

[Prior Art]

Antenna diversity sued for wireless communications and the like is effective means for eliminating influence of fading from received signals, and generally it is a method of receiving signals by two or more receiving systems not closely correlating with each other, and using these signals by synthesizing or switching automatically before or after detection. Typical examples of this method include space diversity and polarization diversity.

[0003]

Space diversity makes use of the fact that variations caused by fading at the points separated from each other in the vicinity of a receiving point are independent of each other. Usually, two or more antennas are arranged so as to be spatially separated from each other, and receive signals separately, and the signals are used after being synthesized or switched.

[0004]

Polarization diversity is a method of receiving signals separately by receiving antennas of polarized waves different from each other by 90°.

[0005]

In either method, a greater diversity gain is obtained when

the correlation of the antennas is lower.

[0006]

Fig. 7 shows a structure of a conventional diversity wireless device (for example, disclosed in Japanese Patent Application Non-Examined Publication No. H07-131229). In Fig. 7, reference numeral 71 is a substrate on which antennas are mounted. Reference numeral 72 is a ground plane formed on the substrate 71. Reference numerals 73 and 74 are antennas, 73a and 74a are feed terminals, and 73b and 74b are ground terminals serving also as antenna supports. Reference numeral 75 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals. The ground of the RF circuit 75 is connected to the ground plane 72.

[0007]

In this structure, the antennas 73 and 74 are so-called inverted F-type antennas, and the ground plane 72 is related to the characteristic of the antenna 73.

[0008]

[Problems to be Solved by the Invention]

Recently, however, there has been a strong demand for downsizing of wireless devices, and the space assigned for antennas is becoming smaller. As a result, sufficient distance cannot be provided between antennas, and the degree of correlation between the antennas connected to a common ground

becomes higher, which causes to lower the diversity gain.

[0009]

It is hence an object of the invention to present a diversity wireless device capable of downsizing without lowering the diversity gain.

[0010]

[Means to Solve the Problems]

The invention presents a diversity wireless device for providing diversity using a plurality of antennas comprising a grounded antenna and an ungrounded antenna.

[0011]

The invention also presents a diversity wireless device for providing diversity using a plurality of ungrounded antennas, in which a ground is placed in proximity to at least one of the ungrounded antennas, and is coupled to the ungrounded antenna at high frequency.

[0012]

Thus, the invention presents a diversity wireless device capable of downsizing without lowering the diversity gain.

[0013]

[Description of the Preferred Embodiments]

The invention as set forth in claim 1 is a diversity wireless device for providing diversity using a plurality of antennas comprising a grounded antenna and an ungrounded antenna, and therefore the wireless device can be reduced in size without

lowering the diversity gain.

[0014]

The invention as set forth in claim 2 relates to the diversity wireless device of claim 1, in which a ground is placed in proximity to the ungrounded antenna, and is coupled to the ungrounded antenna at high frequency, and therefore the ungrounded antenna may have a same characteristic as the grounded antenna without intensifying the correlation between the plural antennas.

[0015]

The invention as set forth in claim 3 relates to the diversity wireless device of claim 1 or 2, in which the directivity of the antennas is manipulated by varying the configuration angle or feed points of the individual antennas, and therefore a diversity effect is obtained efficiently.

[0016]

The invention as set forth in claim 4 is a diversity wireless device for providing diversity using a plurality of ungrounded antennas, wherein a ground is placed in proximity to at least one of the ungrounded antennas, and is coupled to the ungrounded antenna at high frequency, and therefore the ungrounded antenna may have a same characteristic as the grounded antenna, and the diversity is obtained between these antennas.

[0017]

The invention as set forth in claim 5 relates to the

diversity wireless device of claim 4, in which an efficient diversity effect is obtained by manipulating the directivity of the antennas by varying the configuration angle or feed points of the individual antennas, and therefore a diversity effect is obtained efficiently.

[0018]

Preferred embodiments of the invention are described below while referring to Fig. 1 to Fig. 5.

[0019]

(Preferred Embodiment 1)

Fig. 1 is a structural diagram of diversity wireless device in a first preferred embodiment of the invention.

[0020]

In Fig. 1, reference numeral 11 is a substrate on which antennas are mounted. Reference numeral 12 is a ground plane formed on the substrate 11. Reference numeral 13 is a grounded antenna, and numeral 14 is an ungrounded antenna, numerals 13a and 14a are feed terminals, and numeral 13b is a ground terminal for supporting the antenna 13 and connecting the antenna 13 electrically to the ground plane 12. Reference numeral 14b is a support terminal for supporting the antenna. Reference numeral 15 is an RF circuit, which feeds power to the antennas, and processes received signals. The ground of the RF circuit 15 is connected to the ground plane 12.

[0021]

In this structure, the antenna 13 is a so-called inverted F-type antenna, and the ground plane 12 is related to the characteristic of the antenna 13. On the other hand, the antenna 14 is completely isolated from the antenna 13 and grand plane 12. Therefore, the degree of correlation is low between the antenna 13 and antenna 14, and a high diversity gain is obtained by providing diversity by these antennas.

[0022]

Fig. 6 is an appearance view of diversity wireless device in the first preferred embodiment of the invention.

[0023]

In Fig. 6, reference numeral 61 is a diversity wireless device of PC card type, and it has a connector 62 for connecting by inserting into a PC card slot not shown. The diversity wireless device 61 is presented for wireless transmission and reception of data as being connected to network connection device such as gateway having PC card slot or portable PC not shown.

[0024]

(Preferred Embodiment 2)

Fig. 2 is a structural diagram of diversity wireless device in a second preferred embodiment of the invention.

[0025]

In Fig. 2, reference numeral 21 is a substrate on which an antenna is mounted. Reference numeral 22 is a ground plane

formed on the substrate 21. Reference numeral 23 is a grounded antenna, and numeral 24 is an ungrounded antenna, numerals 23a and 24a are feed terminals, and numeral 23b is a ground terminal for supporting the antenna and connecting the antenna 23 electrically to the ground plane 22. Reference numeral 25 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals. The ground of the RF circuit 25 is connected to the ground plane 22.

[0026]

This embodiment is different from embodiment 1 in that the ungrounded antenna 24 is an antenna having a meandering pattern formed on other substrate.

[0027]

Thus, by using the antennas of different structures, the correlation between the antenna 23 and antenna 24 can be lowered, and the diversity effect making use of merits of both antennas can be obtained. It is also possible to form a meandering antenna by patterning on the substrate 11.

[0028]

The same effects of the invention are obtained except for the structure of the antenna of the preferred embodiment.

[0029]

(Preferred Embodiment 3)

Fig. 3 is a structural diagram of diversity wireless device

in a third preferred embodiment of the invention.

[0030]

In Fig. 3, reference numeral 31 is a substrate on which antennas are mounted. Reference numeral 32 is a ground plane formed on the substrate 31. Reference numeral 33 is a grounded antenna, and numeral 34 is an ungrounded antenna, numerals 33a and 34a are feed terminals, and numerals 33b, 34b are ground terminals for supporting the antennas. In particular, the terminal 33b connects the antenna 33 electrically to the ground plane 32. Reference numeral 35 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals. The ground of the RF circuit 15 is connected to the ground plane 12.

[0031]

In this structure, by defining a specific angle between the grounded antenna 33 and ungrounded antenna 34, the correlation between the antenna 33 and antenna 34 can be lowered, and an effect of polarization diversity is obtained, so that a diversity wireless device of a large diversity gain is realized.

[0032]

The same effects of the invention are obtained except for the structure of the antennas of the preferred embodiment.

[0033]

(Preferred Embodiment 4)

Fig. 4 is a structural diagram of diversity wireless device

in a fourth preferred embodiment of the invention.

[0034]

In Fig. 4, reference numeral 41 is a substrate on which antennas are mounted. Reference numeral 42 is a ground plane formed on the substrate 41. Reference numeral 43 is a grounded antenna, and numeral 44 is an ungrounded antenna, numerals 43a and 44a are feed terminals, and numeral 43b is a ground terminal for supporting the antenna and connecting the antenna 43 electrically to the ground plane 42, and 44b is a support terminal for supporting the antenna.

[0035]

In this embodiment, the ground plane 42 is disposed very closely to the support terminal 44b in order to couple the antenna 44 to the ground at high frequency. Reference numeral 45 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals. The ground of the RF circuit 45 is connected to the ground plane 42.

[0036]

In the structure of this embodiment, by high frequency coupling with the antenna 44 disposed very closely to the ground plane 42, the directivity of the antenna 44 is widened, and the correlation between the antenna 43 and antenna 44 can be lowered, and a diversity wireless device of a large diversity gain is obtained.

[0037]

High frequency coupling of the antenna and ground may be realized not only in the surface layer, but also in the inner layer or reverse side.

[0038]

The same effects of the invention are obtained except for the structure of the antennas of the preferred embodiment.

[0039]

(Preferred Embodiment 5)

Fig. 5 is a structural diagram of diversity wireless device in a fifth preferred embodiment of the invention.

[0040]

In Fig. 5, reference numeral 51 is a substrate on which antennas are mounted. Reference numeral 52 is a ground plane formed on the substrate 51. Reference numerals 53 and 54 are both ungrounded antennas, numerals 53a and 54a are feed terminals, and numerals 53b and 54b are support terminals for supporting the antennas, and the ground plane 52 is disposed in a close proximity in order to couple with the ground at high frequency.

[0041]

Reference numeral 55 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals.

[0042]

The ground of the RF circuit 55 is connected to the ground plane 52.

[0043]

In the structure of this embodiment, by high frequency coupling with the ground plane 52 disposed in a close proximity to the antennas 53 and 54, the directivity of each antenna is widened, while keeping a low correlation between the antenna 53 and antenna 54, so that an excellent effect of space diversity is obtained.

[0044]

Further, by setting the angle between the two antennas at 90°, signals in a horizontally polarized wave surface are mainly received by one antenna and signals in a vertically polarized wave surface are mainly received by other antenna, so that an effect of polarization diversity is obtained.

[0045]

High frequency coupling of the antennas and ground may be realized not only in the surface layer, but also in the inner layer or reverse side.

[0046]

The same effects of the invention are obtained except for the structure of the antennas of the preferred embodiment.

[0047]

[Advantage of the Invention]

According to the invention, at least one of the plurality

of the antennas of the diversity wireless device is not grounded, and therefore the correlation between the antennas can be lowered, so that a high diversity gain may be obtained.

[Brief Description of the Drawings]

Fig. 1 is a structural diagram of diversity wireless device in a first preferred embodiment of the invention.

Fig. 2 is a structural diagram of diversity wireless device in a second preferred embodiment of the invention.

Fig. 3 is a structural diagram of diversity wireless device in a third preferred embodiment of the invention.

Fig. 4 is a structural diagram of diversity wireless device in a fourth preferred embodiment of the invention.

Fig. 5 is a structural diagram of diversity wireless device in a fifth preferred embodiment of the invention.

Fig. 6 is an appearance diagram of the diversity wireless device in the first preferred embodiment of the invention.

Fig. 7 is a structural diagram of a conventional diversity wireless device.

[Description of the Reference Numerals]

11 Substrate

12 Ground plane

13 Grounded antenna

13a Feed terminal of antenna

13b Ground terminal of antenna

14 Ungrounded antenna

14a Feed terminal of antenna

14b Support terminal of antenna

15 RF circuit

[Name of the Document] Abstract

[Abstract]

[Object] To present a diversity wireless device reduced in size without lowering the diversity gain.

[Means to Solve the Problems] At least one of the plurality of antennas of a diversity wireless device is not grounded, and therefore the correlation between the antennas is lowered, and a high diversity gain is obtained.

[Selected Drawing] Fig. 1

[Name of the document] Drawing

Fig. 1

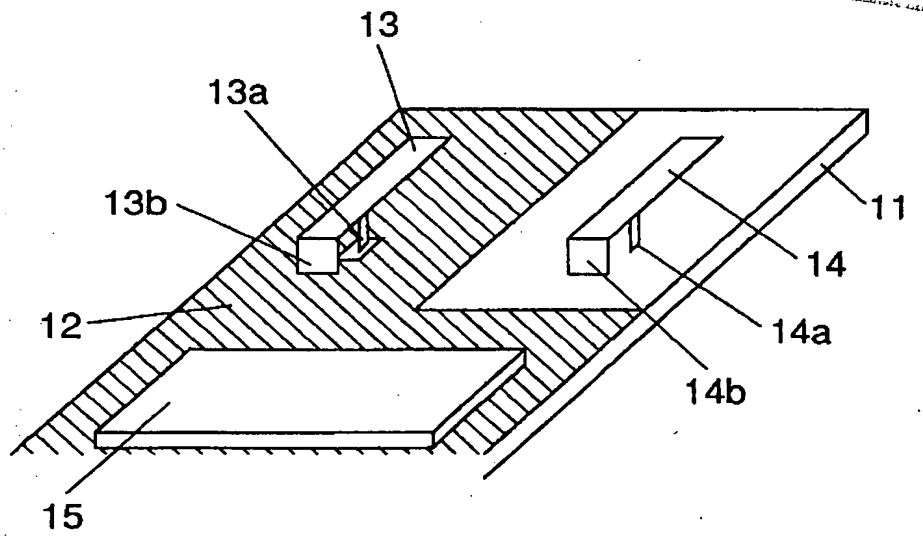


Fig. 2

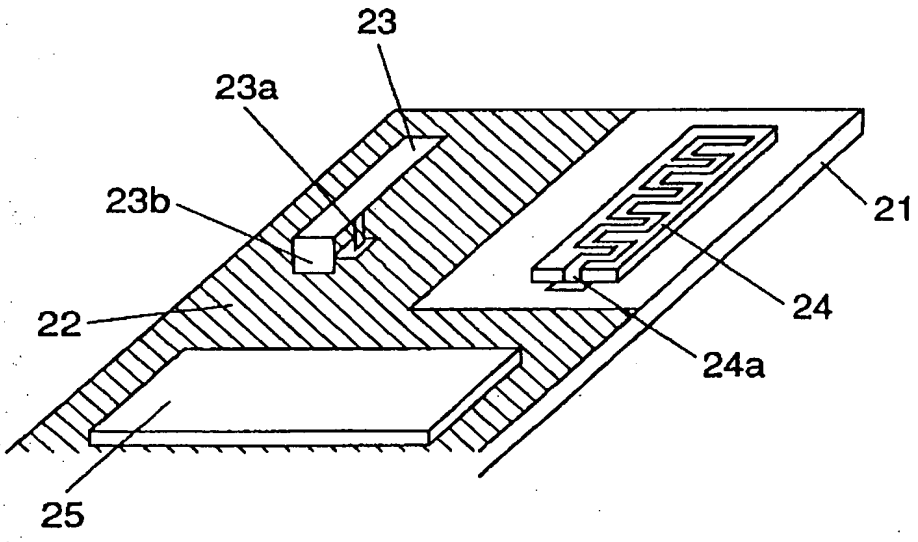


Fig. 3

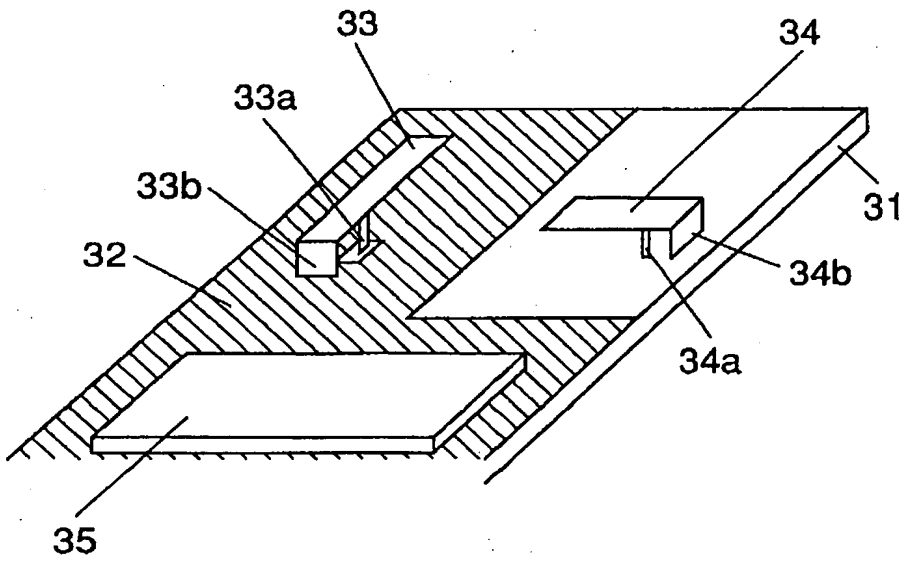


Fig. 4

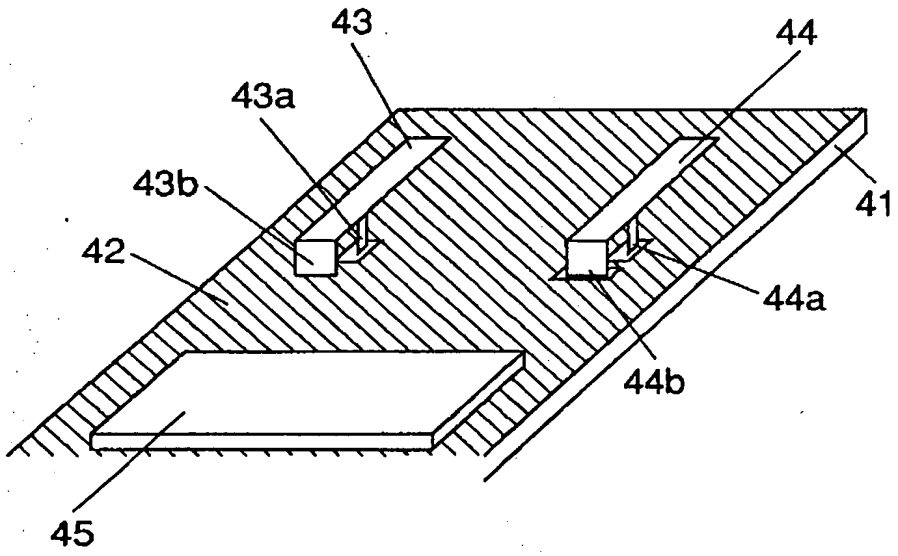


Fig. 5

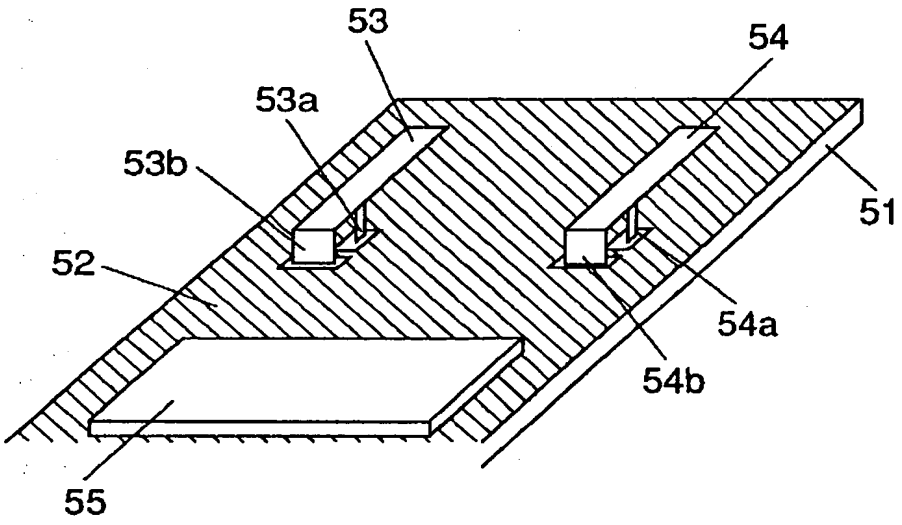


Fig. 6

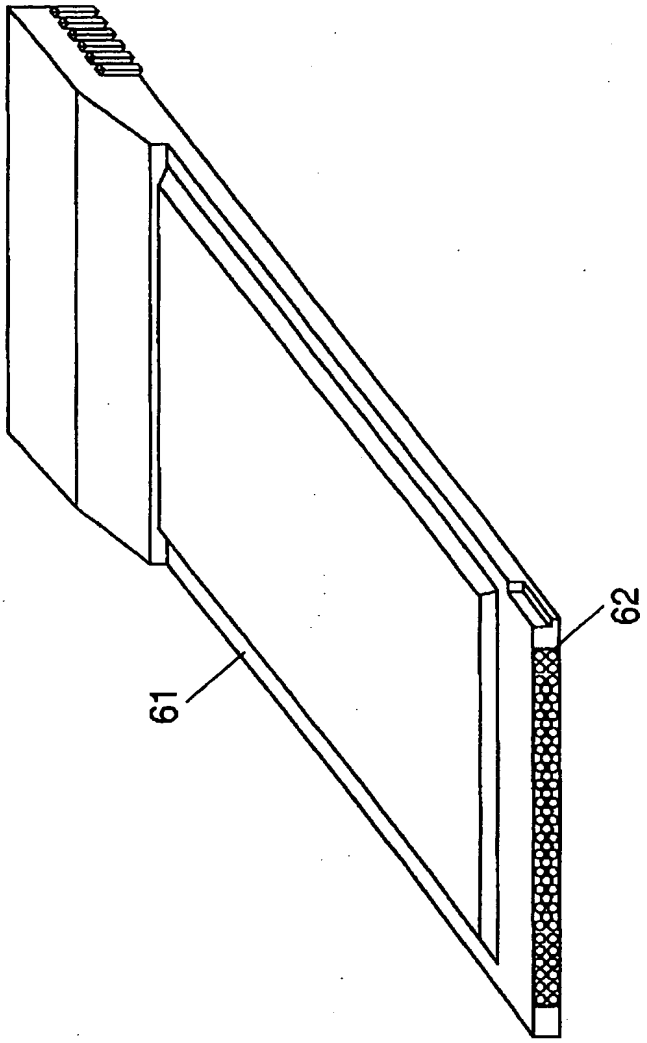
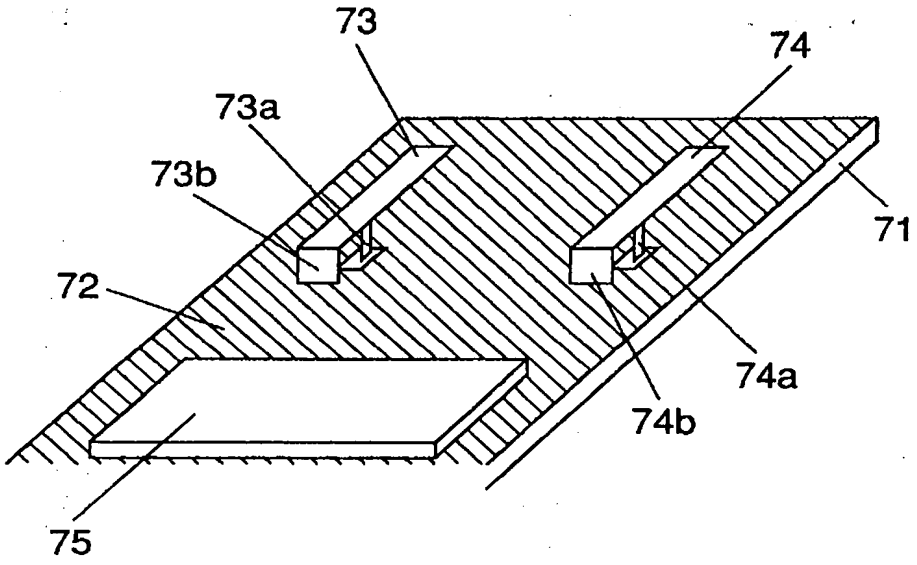


Fig. 7



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Date: 28 January, 2003

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2000-283025

[NAME OF THE DOCUMENT] Patent Application
[ARRANGEMENT NUMBER] 2913020899
[DATE OF FILING] September 19, 2000
[ADDRESS] Director-General of the Patent Office
[INTERNATIONAL PATENT CLASSIFICATION] H04B 7/02
[TITLE OF THE INVENTION] Wireless Terminal Device
[NUMBER OF CLAIMS] 5

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[REPRESENTATION OF FEE]
[PAYING METHOD] In-advance payment
[NUMBER IN LEDGER OF IN-ADVANCE PAYMENT] 011305
[AMOUNT] 21000

[LIST OF ARTICLES FILED]
[NAME OF ARTICLE] Specification 1
[NAME OF ARTICLE] Drawing 1
[NAME OF ARTICLE] Abstract 1

[NUMBER OF GENERAL POWER OF ATTORNEY] 9809938

[Name of the Document] Specification

[Title of the Invention] Wireless terminal device

[What is claimed is]

[Claim 1] A wireless terminal device having an antenna element composed of a first conductor section substantially parallel to a circuit board, and a second conductor section consecutive to the first conductor section and inclined to the circuit board.

[Claim 2] A wireless terminal device having an antenna element composed of a first conductor section substantially parallel to a circuit board, and a second conductor section consecutive to the first conductor section and inclined to the circuit board, wherein a feed terminal is provided in the first conductor section, and the second conductor section is formed so as to include an end face remote from the feed terminal.

[Claim 3] A wireless terminal device having two antenna elements each composed of a first conductor section substantially parallel to a circuit board, and a second conductor section consecutive to the first conductor section and inclined to the circuit board, wherein a feed terminal is provided in the first conductor section, the second conductor section is formed so as to include an end face remote from the feed terminal, diversity is provided by the two antenna elements, and the two antenna terminals are configured substantially laterally symmetrical with respect to a width direction of the

wireless terminal device.

[Claim 4] A wireless terminal device having at least two internal antenna elements each composed of a first conductor section substantially parallel to a circuit board, and a second conductor section consecutive to the first conductor section and inclined to the circuit board, wherein a feed terminal is provided in the first conductor section, the second conductor section is formed so as to include an end face remote from the feed terminal, a connector for external antenna with a changeover switch is provided, and when an external antenna is connected to the connector, one internal antenna of the internal antennas in the wireless terminal device is changed over to the external antenna, and diversity is provided by the external antenna and other internal antenna in the wireless terminal device.

[Claim 5] The wireless terminal device of claim 3 or 4, wherein the antenna terminals are not grounded, and a ground is placed in proximity to at least one antenna terminal, and is coupled at high frequency with the ungrounded antenna terminals.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a wireless terminal device, and more particularly to a wireless terminal device having

features in antenna terminal and used as wireless PC card or the like for wireless LAN.

[0002]

[Prior Art]

In recent years, with the progress of networking in offices and at home, a plurality of personal computers (PCs), printers and others are connected via Ethernet or the like to compose LANs. On the other hand, to avoid wiring troubles when changing the layout or difficulty of new wiring installation, wireless networking has been drawing attention, and in particular since the transmission speed of 11 Mbps equivalent to that of wired devices has been standardized by IEEE802.11, cheaper wireless LANs are being built up.

[0003]

An adapter for wireless LAN is presented as a wireless PC card, in which the space to be occupied by the wireless part is limited. Therefore, the wireless part including the antenna part has special features in its structure.

[0004]

Conventional wireless PC cards are disclosed, for example, in Japanese Patent Publication No. 3004533 and Japanese Utility Model Publication No. 3041690, both of which are built with inverted F-type antennas.

[0005]

Fig. 4 (a) is a perspective view of appearance of a

conventional wireless PC card as a portable wireless terminal device, (b) is a perspective view of antenna section of the conventional wireless PC card as a portable wireless terminal device, and (c) is a sectional view including the enclosure along line X-X of Fig. 4 (b).

[0006]

As shown in Fig. 4, the wireless PC card has a conductor section 51 as a first antenna element, a conductor section 52 as a second antenna element, and a circuit board 57 having a ground plane 58, and the conductor section 51 as first antenna element and conductor section 52 as second antenna element respectively include feed terminals 53, 55 and ground terminals 54, 55 bending at and protruding from the edges, and are grounded to the ground plane 58 on the circuit board 57 through the ground terminal 53, 54, thereby operating as an inverted F-type antenna.

[0007]

Reference numeral 59 is a frame as an outer casing, numeral 60 is a top sheet metal cover, numeral 61 is a bottom sheet metal cover, and numeral 62 is an extended part including antenna elements.

[0008]

Fig. 4 shows two antenna elements, but only one antenna element is enough. Two antennas are used in order to realize diversity reception by the first antenna element 51 and second

antenna element 52, and select an antenna of better characteristics by changing over the antenna elements by a switch (not shown) depending on changes of reception wave intensity due to effects of fading or the like.

[0009]

Generally, the size of the extended part of a wireless PC card of type II used as wireless LAN card is specified by the PC card standard, which measures 54 mm in width, 40 mm in length, and 10.5 mm in height. The inverted F-type antenna is excellent in performance and can be reduced in size, and it is hence used widely in wireless PC card.

[0010]

[Problems to be Solved by the Invention]

Characteristics of the inverted F-type antenna are better when the distance from the circuit board 57 to the conductor sections 51, 52 is longer (the distance h shown in Fig. 4), and therefore it is important to keep a long distance h in order to obtain favorable characteristics of the inverted F-type antenna. However, if the distance h is defined to the limit of the standard, the extended part 62 including the antenna is too large as shown in Fig. 4 (a), and the degree of freedom of design is spoiled.

[0011]

In the light of the problems of the prior art, it is hence an object of the invention to present a wireless terminal device

using a small inverted F-type antenna of excellent characteristics, and having an attractive design to users.

[0012]

[Means to Solve the Problems]

To achieve the object, the invention presents a wireless terminal device having an antenna element composed of a first conductor section substantially parallel to a circuit board, and a second conductor section consecutive to the first conductor section and inclined to the circuit board.

[0013]

According to the invention, since the height of the antenna element can be varied, a wireless terminal device enhanced in the degree of freedom of design of the antenna part is realized.

[0014]

[Description of the Preferred Embodiments]

The invention as set forth in claim 1 is a wireless terminal device having an antenna element composed of a first conductor section substantially parallel to a circuit board, and a second conductor section consecutive to the first conductor section and inclined to the circuit board, and therefore since the height of the antenna element can be varied, the degree of freedom of design of the antenna part of the wireless terminal device is enhanced.

[0015]

The invention as set forth in claim 2 is a wireless terminal

device having an antenna element composed of a first conductor section substantially parallel to a circuit board, and a second conductor section consecutive to the first conductor section and inclined to the circuit board, in which a feed terminal is provided in the first conductor section, and the second conductor section is formed so as to include an end face remote from the feed terminal, and therefore the degree of freedom of design of the antenna part is enhanced, and further the distance between the feed terminal and circuit board can be extended, so that favorable characteristics can be obtained as the antenna.

[0016]

The invention as set forth in claim 3 is a wireless terminal device having two antenna elements each composed of a first conductor section substantially parallel to a circuit board, and a second conductor section consecutive to the first conductor section and inclined to the circuit board, in which a feed terminal is provided in the first conductor section, the second conductor section is formed so as to include an end face remote from the feed terminal, diversity is provided by the two antenna elements, and the two antenna terminals are configured substantially laterally symmetrical with respect to a width direction of the wireless terminal device, and therefore the degree of freedom of design of the antenna part is enhanced, favorable characteristics as the antenna elements can be

obtained, and also the characteristics of the two right and left antenna elements can be nearly equalized, so that an excellent diversity effect can be obtained.

[0017]

The invention as set forth in claim 4 is a wireless terminal device having at least two internal antenna elements each composed of a first conductor section substantially parallel to a circuit board, and a second conductor section consecutive to the first conductor section and inclined to the circuit board, in which a feed terminal is provided in the first conductor section, the second conductor section is formed so as to include an end face remote from the feed terminal, a connector for external antenna with a changeover switch is provided, and when an external antenna is connected to the connector, one internal antenna of the internal antennas in the wireless terminal device is changed over to the external antenna, and diversity is provided by the external antenna and other internal antenna in the wireless terminal device, and therefore if the external antenna is used, the antennas are changed over automatically, and diversity is realized.

[0018]

The invention as set forth in claim 5 relates to the wireless terminal device of claim 3 or 4, in which the antenna terminals are not grounded, and a ground is placed in proximity to at least one antenna terminal, and is coupled at high frequency with the

ungrounded antenna terminals, and therefore the degree of freedom of design of the antenna part is enhanced, favorable characteristics as the antenna elements can be obtained, and also the wireless terminal device can be reduced in size without lowering the diversity gain.

[0019]

Preferred embodiments of the invention are described below while referring to the drawings.

[0020]

(Preferred Embodiment 1)

Fig. 1 (a) is a perspective view of appearance of a wireless PC card as a wireless terminal device in preferred embodiment 1 of the invention, (b) is a perspective view of antenna section of the wireless PC card as the wireless terminal device in preferred embodiment 1 of the invention, and (c) is a sectional view including the enclosure along line X-X of Fig. 1 (b).

[0021]

The wireless PC card comprises a first antenna element 1, a second antenna element 2, and a circuit board 7 having a ground plane 8.

[0022]

The first antenna element 1 is composed of a first conductor section 1a made of sheet metal or the like, and a second conductor section 1b made of sheet metal or the like consecutive to the first conductor section 1a by folding at an obtuse angle, and

at the edge of the first conductor section 1a, a feed terminal 3 to the antenna element and a ground terminal 4 of the antenna element are folded to protrude, and the second antenna element 2 is composed of a first conductor section 2a made of sheet metal or the like, and a second conductor section 2b made of sheet metal or the like consecutive to the first conductor section 2a by folding at an obtuse angle, and at the edges of the first conductor sections 1a and 2a, a feed terminal 5 to each antenna element and a ground terminal 6 of the antenna elements are folded to protrude. The second conductor sections 1b, 2b of the first antenna element 1 and second antenna element 2 are composed to include the end faces remote from the feed terminal 5 of the first conductor sections 1a, 2a.

[0023]

The first antenna element 1 and second antenna element 2 are grounded to the ground plane 8 of the circuit board 7 by way of the ground terminals 4, 6, and are designed to act as inverted F-type antenna.

[0024]

More specifically, the first conductor section 1a of the first antenna element 1 and the first conductor section 2a of the second antenna element 2 are disposed parallel to the surface of the circuit board 7 by means of the feed terminals 3, 5, at a long distance from the surface of the circuit board 7, and the second conductor sections 1b, 2b are installed at an

inclination to the circuit board 7.

[0025]

In the drawing, reference numeral 9 is a frame as an outer casing, numeral 10 is a top sheet metal cover, numeral 11 is a bottom sheet metal cover, and numeral 12 is an extended part including antenna elements.

[0026]

By thus forming the antenna elements 1, 2, the shape of the extended part 12 including the antenna part of the wireless PC card is not limited to a simple box shape design, but the shape of the extended part 12 may be reduced in size along the antenna elements 1, 2, so that the extended part 12 may look smaller than the actual size.

[0027]

The gain characteristic of the antenna element is described. In this preferred embodiment, the shape of the second antenna element 2 shown in Fig. 1 is used. The spacing from the circuit board 7 is 5.5 mm, the leading end by 5 mm is inclined at an angle of 20° through the circuit board 7. In the prior arts, the second antenna element 52 shown in Fig. 4 is used, and the spacing from the circuit board 7 is set at 3 mm and 5.5 mm. In a radio wave darkroom, continuous waves of 2.4 GHz were transmitted from a standard horn antenna, and received by test antenna elements. By rotating the antenna element by 360°, the gain characteristics were measured by a spectrum analyzer, and

the average was obtained as the measurement for a specific antenna element.

[0028]

Results are shown in Table 1.

[0029]

[Table 1]

	Spacing from circuit board [mm]	Antenna gain [dBi]
Preferred embodiment	5.5	−3.92
Prior art 1	3.0	−7.83
Prior art 2	5.5	−3.42

[0030]

In the prior arts, by widening the spacing from the circuit board 7, the gain characteristics of the antenna element were improved by about 4.4 dB. In prior art 1, however, the extended part 12 of the wireless PC card is increased in size. In the preferred embodiment, as compared with prior art 2, the performance is improved by about 3.9 dB, but the performance is slightly inferior as compared with prior art 1, but the design of the extended part 12 is superior because the shape of the extended part 12 can be reduced in size along the antenna element.

[0031]

Thus, in the configuration of preferred embodiment 1, the

shape of the extended part 12 can be reduced in size along the antenna element while assuring the performance as the antenna element, and the extended part 12 looks smaller than the actual size, which is an appealing point to the users.

[0032]

In preferred embodiment 1, two inverted F-type antennas are used, but the invention is not limited by the shape of antenna element or kind of antenna element, and it is also possible to combine with other kind of antenna element. Moreover, the wireless terminal device is not limited to the wireless PC card.

[0033]

(Preferred Embodiment 2)

Fig. 2 is a perspective view of appearance of antenna part of a wireless PC card in preferred embodiment 2 of the invention.

[0034]

The wireless PC card comprises, as shown in Fig. 2, a first antenna element 21, a second antenna element 22, and a circuit board 27 having a ground plane 28.

[0035]

The first antenna element 21 is composed of a first conductor section 21a made of sheet metal or the like, and a second conductor section 21b made of sheet metal or the like consecutive to the first conductor section 21a by folding at an obtuse angle, and at the edge of the first conductor section 21a, a feed terminal 23 to the antenna element and a ground terminal 24 of

the antenna element are folded to protrude, and the second antenna element 22 is composed of a first conductor section 22a made of sheet metal or the like, and a second conductor section 22b made of sheet metal or the like consecutive to the first conductor section 22a by folding at an obtuse angle, and at the edge of the first conductor section 22a, a feed terminal 25 to the antenna element and a ground terminal 26 of the antenna element are folded to protrude. The first antenna element 21 and second antenna element 22 are grounded to the ground plane 28 on the circuit board 27 by means of the ground terminals 24, 26 to act as inverted F-type antenna.

[0036]

More specifically, the first conductor section 21a of the first antenna element 21 and the first conductor section 22a of the second antenna element 22 are disposed parallel to the surface of the circuit board 27 by means of the feed terminals 23, 25, at a long distance from the surface of the circuit board 27, and the second conductor sections 21b, 22b are installed at an inclination to the circuit board 27.

[0037]

It is a feature of preferred embodiment 2 that the first antenna element 21 and second antenna element 22 are configured substantially laterally symmetrical with respect to a width direction of the wireless PC card.

[0038]

In the wireless PC card, diversity reception is executed in order to suppress effects of diversity, and by the configuration as in preferred embodiment 2, the gain characteristics of the two antenna elements can be substantially equalized, and the directivity is almost symmetrical laterally, so that an effective diversity reception may be realized.

[0039]

In preferred embodiment 2, meanwhile, by slightly varying the size of the right and left antenna elements, it is possible to correct deviation of matching point at the operating frequency of the antenna elements due to effects of layout of the peripheral parts. For example, the length of the second conductor section 21b of the first antenna element 1 may be set longer than the length of the second conductor section 22b of the second antenna 2, or other methods may be freely selected depending on the composition of circuit.

[0040]

In preferred embodiment 2, two inverted F-type antennas are used, but the invention is not limited by the shape of antenna element or kind of antenna element. Moreover, the wireless terminal device is not limited to the wireless PC card.

[0041]

(Preferred Embodiment 3)

Fig. 3 is a perspective view of appearance of antenna part

of a wireless PC card in preferred embodiment 3 of the invention.

[0042]

The wireless PC card comprises, as shown in Fig. 3, a first antenna element 31, a second antenna element 32, and a circuit board 37 having a ground plane 38.

[0043]

The first antenna element 31 is composed of a first conductor section 31a made of sheet metal or the like, and a second conductor section 31b made of sheet metal or the like consecutive to the first conductor section 31a by folding at an obtuse angle, and at the edge of the first conductor section 31a, a feed terminal 33 to the antenna element and a support terminal 34 of the antenna element are folded to protrude, and the second antenna element 32 is composed of a first conductor section 32a made of sheet metal or the like, and a second conductor section 32b made of sheet metal or the like consecutive to the first conductor section 32a by folding at an obtuse angle, and at the edge of the first conductor section 32a, a feed terminal 35 to the antenna element and a support terminal 36 of the antenna element are folded to protrude. In the circuit board 37, on the top of its ground plane 38, a conductor section 39a and a conductor section 39b having an electrically insulating relation from the ground plane 38 are formed. The ungrounded first antenna element 31 and second antenna element 32 are coupled with the conductor section 39a and conductor section

39b at high frequency, and the conductor section 39a and conductor section 39b form part of the conductor section of the first antenna element 31 and second antenna element 32.

[0044]

The first conductor section 31a of the first antenna element 31 and the first conductor section 32a of the second antenna element 32 are disposed parallel to the surface of the circuit board 27 by means of the feed terminals 33, 35, at a long distance from the surface of the circuit board 37, and the second conductor sections 31b, 32b are installed at an inclination to the circuit board 37. Reference numeral 40 in the drawing is a connector with a changeover switch, and numeral 41 is an external antenna.

[0045]

The operation is same as in preferred embodiment 1, and its explanation is omitted.

[0046]

It is a feature of preferred embodiment 3 that the first antenna element 31 and second antenna element 32 are not grounded.

[0047]

In such configuration, while keeping a low correlation between the first antenna element 31 and second antenna element 32, the ground plane 38 is disposed at close proximity to the antenna elements 31, 32, and coupled at high frequency, and therefore

each antenna has a wide directivity, and an excellent diversity effect is obtained.

[0048]

The antenna elements and the ground plane may be coupled at high frequency not only in the surface layer, but also, for example, in the inner layer or reverse side of the multilayer circuit board.

[0049]

This preferred embodiment 3 comprises the connector 40 with changeover switch, and when the external antenna 41 is connected to the connector 40, the second antenna element 32 is changed over to the external antenna 41, and the diversity is realized by the external antenna 41 and first antenna element 31.

[0050]

The position of the connector 40 is preferred to be located between the two antenna elements in relation to the layout of circuit parts, but the position is not particularly specified.

[0051]

In preferred embodiment 3, two inverted F-type antennas are used, but the invention is not limited by the shape of antenna element or kind of antenna element. Moreover, the wireless terminal device is not limited to the wireless PC card.

[0052]

[Advantage of the Invention]

According to the invention, as clear from the description

herein, the degree of freedom of design of the antenna part is enhanced, and the distance between the feed terminal and circuit board is set longer, so that a wireless terminal device having a favorable characteristic as antenna may be presented. Moreover, the characteristics of the two antenna elements may be substantially equalized, and a wireless terminal device having an excellent diversity effect may be presented. Further, when an external antenna is used, a wireless terminal device capable of changing over antennas and executing diversity may be presented. At the same time, the antenna size can be reduced, and each antenna comes to have a wider directivity, so that a wireless terminal device having an excellent diversity effect may be presented.

[Brief Description of the Drawings]

Fig. 1 (a) is a perspective view of appearance of a wireless PC card as a wireless terminal device in preferred embodiment 1 of the invention,

Fig. 1 (b) is a perspective view of antenna section of the wireless PC card as the wireless terminal device in preferred embodiment 1 of the invention, and

Fig. 1 (c) is a sectional view including the enclosure along line X-X of Fig. 1 (b).

Fig. 2 is a perspective view of appearance of antenna part of a wireless PC card in preferred embodiment 2 of the invention.

Fig. 3 is a perspective view of appearance of antenna part

of a wireless PC card in preferred embodiment 3 of the invention.

Fig. 4 (a) is a perspective view of appearance of a conventional wireless PC card as a wireless terminal device,

Fig. 4 (b) is a perspective view of antenna section of the conventional wireless PC card as the wireless terminal device, and

Fig. 4 (c) is a sectional view including the enclosure along line X-X of Fig. 4 (b).

[Description of the Reference Numerals]

1	First antenna element
1a	First conductor section
1b	Second conductor section
2	Second antenna element
3, 5	Feed terminal
4, 6	Ground terminal
7	Circuit board
8	Ground plane
9	Frame
10	Top sheet metal cover
11	Bottom sheet metal cover
12	Extended part
34, 36	Support terminal
39a,39b	Conductor section on circuit board
40	Connector
41	External antenna

[Name of the Document] Abstract

[Abstract]

[Object] To present a wireless terminal device having an attractive design feature of antenna section without deteriorating the characteristics of antenna elements.

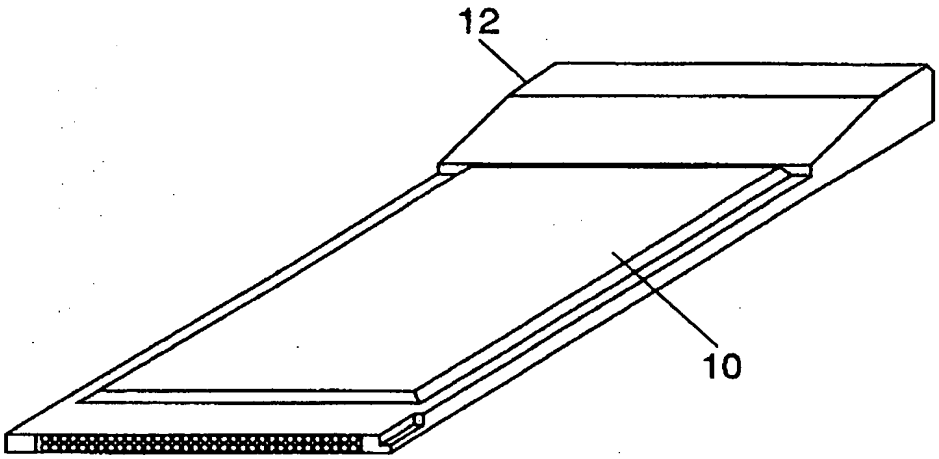
[Means to Solve the Problems] A first antenna element 1 is composed of a first conductor section 1a substantially parallel to a circuit board 7, and a second conductor section 1b consecutive to the first conductor section 1a and inclined to the circuit board 7, a feed terminal 3 is provided in the first conductor section 1a, the second conductor section 1b is formed so as to include an end face remote from the feed terminal 3. The wireless terminal device performs diversity reception by disposing two antenna elements 1, 2, configured substantially laterally symmetrical with respect to a width direction of the wireless terminal device.

[Selected Drawing] Fig. 1

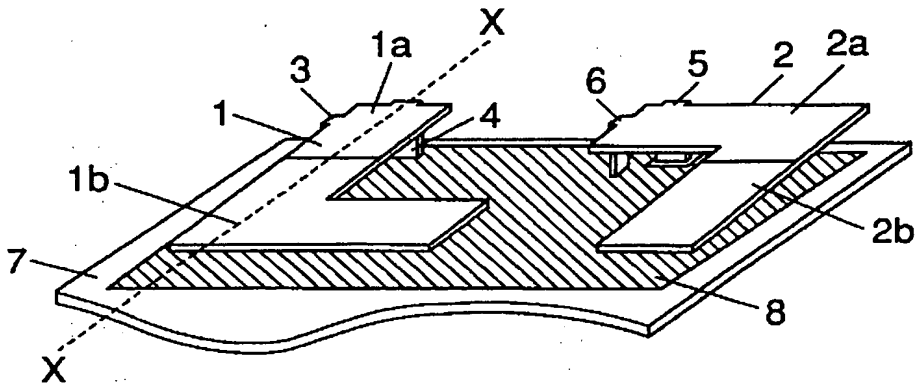
[Name of the document] Drawing

Fig. 1

(a)



(b)



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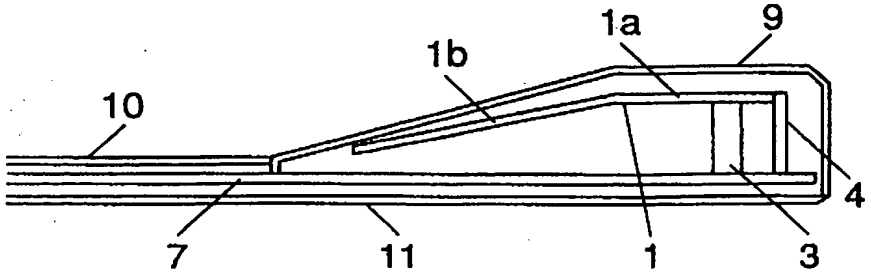


Fig. 2

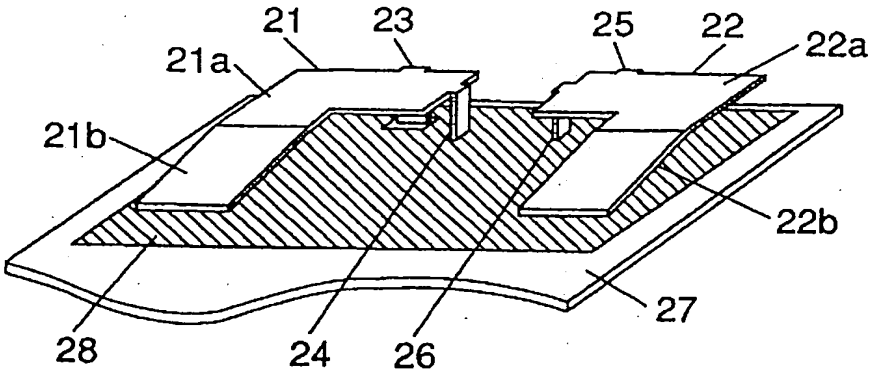


Fig. 3

31, 32	Antenna element
31a, 32a	First conductor section
31b, 32b	Second conductor section
33, 35	Feed terminal
34, 36	Support terminal
37	Circuit board
38	Ground plane
39a, 39b	Conductor section
41	External antenna

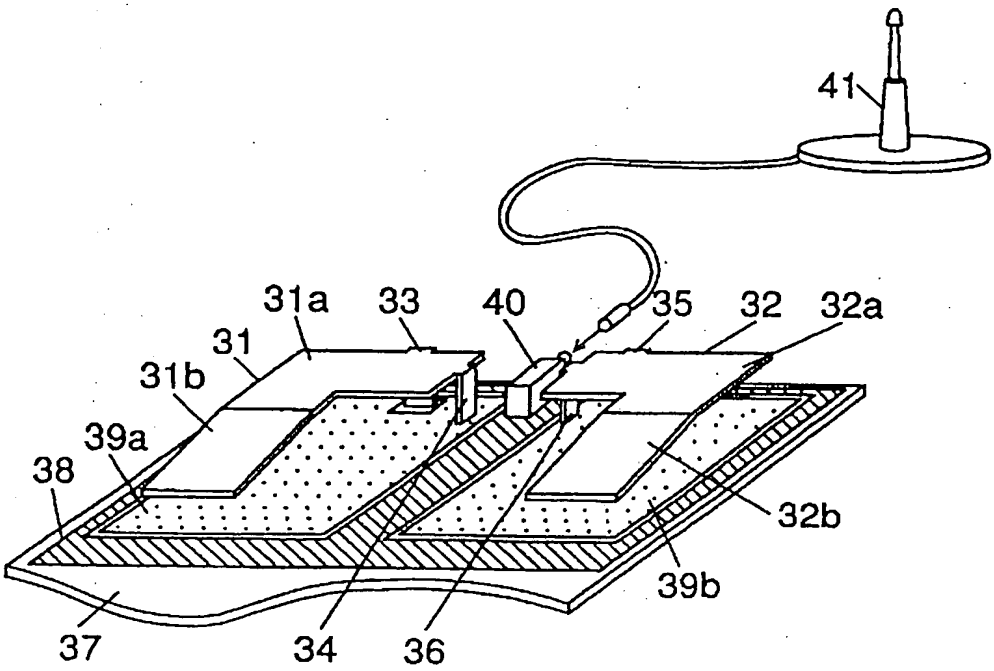
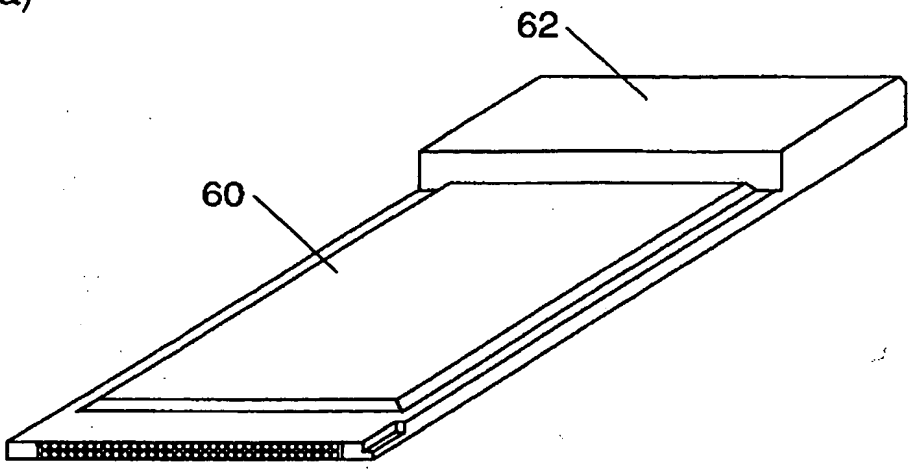


Fig. 4

(a)



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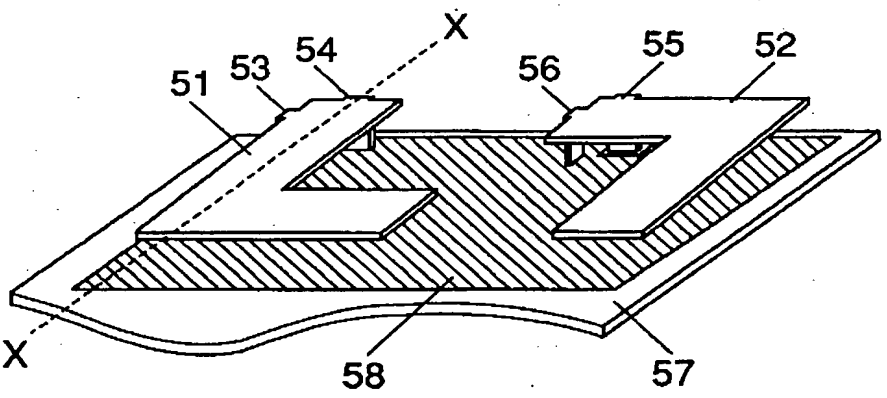

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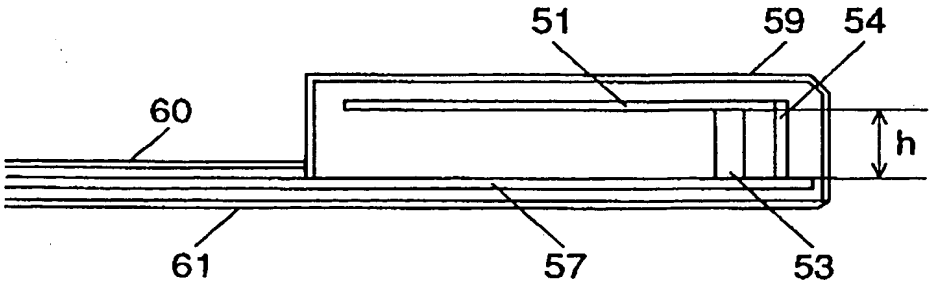

MAT-8117US

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Masakazu Hoashi et al. : Art Unit
Serial No.: 09/820,077 : Examiner
Filed: March 28, 2001 :
FOR: DIVERSITY WIRELESS DEVICE AND WIRELESS TERMINAL UNIT

VERIFICATION OF A TRANSLATION

Assistant Commissioner for Patents
Washington, D.C. 20231
SIR :

I, the below named translator, hereby declare that:

1. My name and post office address are as stated below.

2. The document for which the attached English translation is being submitted is a patent application on an invention entitled DIVERSITY WIRELESS DEVICE AND WIRELESS TERMINAL UNIT.

3. That I am knowledgeable in the English language and in the language of JP2000-292071, and I believe the attached English translation to be a true and complete translation of JP2000-292071.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 28 January, 2003

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[NAME OF THE DOCUMENT] Patent Application
[ARRANGEMENT NUMBER] 2913020943
[DATE OF FILING] September 26, 2000
[ADDRESS] Director-General of the Patent Office
[INTERNATIONAL PATENT CLASSIFICATION] H01Q 1/32
[TITLE OF THE INVENTION] Diversity Wireless Device
[NUMBER OF CLAIMS] 7

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[THE PRIORITY CLAIMED BASED ON THE PRIOR APPLICATION]
[APPLICATION NUMBER] 2000-090367
[DATE OF FILING] March 29, 2000

[REPRESENTATION OF FEE]
[PAYING METHOD] In-advance payment
[NUMBER IN LEDGER OF IN-ADVANCE PAYMENT] 011305
[AMOUNT] 21000

[LIST OF ARTICLES FILED]
[NAME OF ARTICLE] Specification 1
[NAME OF ARTICLE] Drawing 1
[NAME OF ARTICLE] Abstract 1

[NUMBER OF GENERAL POWER OF ATTORNEY] 9809938

[Name of the Document] Specification

[Title of the Invention] Diversity wireless device

[What is claimed is]

[Claim 1] A diversity wireless device for providing diversity using a plurality of antennas comprising a grounded antenna and an ungrounded antenna.

[Claim 2] The diversity wireless device of claim 1, wherein a ground is placed in proximity to the ungrounded antenna, and is coupled to the ungrounded antenna at high frequency.

[Claim 3] The diversity wireless device of claim 1 or 2, wherein an efficient diversity effect is obtained by manipulating the directivity of the antennas by varying the configuration angle or feed points of the individual antennas.

[Claim 4] A diversity wireless device for providing diversity using a plurality of ungrounded antennas, wherein a ground is placed in proximity to at least one of the ungrounded antennas, and is coupled to the ungrounded antenna at high frequency.

[Claim 5] The diversity wireless device of claim 4, wherein an efficient diversity effect is obtained by manipulating the directivity of the antennas by varying the configuration angle or feed points of the individual antennas.

[Claim 6] A diversity wireless device for providing diversity using a plurality of antennas comprising at least one ungrounded antenna, wherein a ground is disposed to surround

the circumference of part of the ungrounded antenna, and the ungrounded antenna and the ground are coupled to each other at high frequency.

[Claim 7] The diversity wireless device of claim 6, wherein said ground is composed of a plurality of laminated layers, and the ground is disposed to surround the circumference of part of the ungrounded antenna three-dimensionally, and the ungrounded antenna and the ground are coupled to each other at high frequency.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a diversity wireless device used for wireless communications.

[0002]

[Prior Art]

Antenna diversity sued for wireless communications and the like is effective means for eliminating influence of fading from received signals, and generally it is a method of receiving signals by two or more receiving systems not closely correlating with each other, and using these signals by synthesizing or switching automatically before or after detection. Typical examples of this method include space diversity and polarization diversity.

[0003]

Space diversity makes use of the fact that variations caused by fading at the points separated from each other in the vicinity of a receiving point are independent of each other. Usually, two or more antennas are arranged so as to be spatially separated from each other, and receive signals separately, and the signals are used after being synthesized or switched.

[0004]

Polarization diversity is a method of receiving signals separately by receiving antennas of polarized waves different from each other by 90°.

[0005]

In either method, a greater diversity gain is obtained when the correlation of the antennas is lower.

[0006]

Fig. 11 shows a structure of a conventional diversity wireless device (for example, disclosed in Japanese Patent Application Non-Examined Publication No. H07-131229). In Fig. 11, reference numeral 91 is a substrate on which antennas are mounted. Reference numeral 92 is a ground plane formed on the substrate 91. Reference numerals 93 and 94 are antennas, numerals 93a and 94a are feed terminals, and numerals 93b and 94b are ground terminals serving also as antenna supports. Reference numeral 95 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals. The ground of the

RF circuit 95 is connected to the ground plane 92.

[0007]

In this structure, the antennas 93 and 94 are so-called inverted F-type antennas, and the ground plane 92 is related to the characteristic of the antenna 93.

[0008]

[Problems to be Solved by the Invention]

Recently, however, there has been a strong demand for downsizing of wireless devices, and the space assigned for antennas is becoming smaller. As a result, sufficient distance cannot be provided between antennas, and the degree of correlation between the antennas connected to a common ground becomes higher, which causes to lower the diversity gain.

[0009]

It is hence an object of the invention to present a diversity wireless device capable of downsizing without lowering the diversity gain.

[0010]

[Means to Solve the Problems]

The invention presents a diversity wireless device for providing diversity using a plurality of antennas comprising a grounded antenna and an ungrounded antenna.

[0011]

The invention also presents a diversity wireless device for providing diversity using a plurality of ungrounded antennas,

in which a ground is placed in proximity to at least one of the ungrounded antennas, and is coupled to the ungrounded antenna at high frequency.

[0012]

Thus, the invention presents a diversity wireless device capable of downsizing without lowering the diversity gain.

[0013]

[Description of the Preferred Embodiments]

The invention as set forth in claim 1 is a diversity wireless device for providing diversity using a plurality of antennas comprising a grounded antenna and an ungrounded antenna, and therefore the wireless device can be reduced in size without lowering the diversity gain.

[0014]

The invention as set forth in claim 2 relates to the diversity wireless device of claim 1, in which a ground is placed in proximity to the ungrounded antenna, and is coupled to the ungrounded antenna at high frequency, and therefore the ungrounded antenna may have a same characteristic as the grounded antenna without intensifying the correlation between the plural antennas.

[0015]

The invention as set forth in claim 3 relates to the diversity wireless device of claim 1 or 2, in which the directivity of the antennas is manipulated by varying the

configuration angle or feed points of the individual antennas, and therefore a diversity effect is obtained efficiently.

[0016]

The invention as set forth in claim 4 is a diversity wireless device for providing diversity using a plurality of ungrounded antennas, wherein a ground is placed in proximity to at least one of the ungrounded antennas, and is coupled to the ungrounded antenna at high frequency, and therefore the ungrounded antenna may have a same characteristic as the grounded antenna, and the diversity is obtained between these antennas.

[0017]

The invention as set forth in claim 5 relates to the diversity wireless device of claim 4, in which an efficient diversity effect is obtained by manipulating the directivity of the antennas by varying the configuration angle or feed points of the individual antennas, and therefore a diversity effect is obtained efficiently.

[0018]

The invention as set forth in claim 6 is a diversity wireless device for providing diversity using a plurality of antennas comprising at least one ungrounded antenna, in which a ground is disposed to surround the circumference of part of the ungrounded antenna, and the ungrounded antenna and the ground are coupled to each other at high frequency, and therefore while the correlation between the plural antennas is kept low, each

antenna has a wide directivity, so that a favorable effect of space diversity is obtained.

[0019]

The invention as set forth in claim 7 relates to the diversity wireless device of claim 6, in which the ground is composed of a plurality of laminated layers, and the ground is disposed to surround the circumference of part of the ungrounded antenna three-dimensionally, and the ungrounded antenna and the ground are coupled to each other at high frequency, and therefore while the correlation between the plural antennas is kept low, each antenna has a wide directivity, so that a favorable effect of space diversity is obtained.

[0020]

Preferred embodiments of the invention are described below while referring to Fig. 1 to Fig. 9.

[0021]

(Preferred Embodiment 1)

Fig. 1 is a structural diagram of diversity wireless device in a first preferred embodiment of the invention.

[0022]

In Fig. 1, reference numeral 11 is a substrate on which antennas are mounted. Reference numeral 12 is a ground plane formed on the substrate 11. Reference numeral 13 is a grounded antenna, and numeral 14 is an ungrounded antenna, numerals 13a and 14a are feed terminals, and numeral 13b is a ground terminal

for supporting the antenna 13 and connecting the antenna 13 electrically to the ground plane 12. Reference numeral 14b is a support terminal for supporting the antenna. Reference numeral 15 is an RF circuit, which feeds power to the antennas, and processes received signals. The ground of the RF circuit 15 is connected to the ground plane 12.

[0023]

In this structure, the antenna 13 is a so-called inverted F-type antenna, and the ground plane 12 is related to the characteristic of the antenna 13. On the other hand, the antenna 14 is completely isolated from the antenna 13 and grand plane 12. Therefore, the degree of correlation is low between the antenna 13 and antenna 14, and a high diversity gain is obtained by providing diversity by these antennas.

[0024]

Fig. 10 is an appearance view of diversity wireless device in the first preferred embodiment of the invention.

[0025]

In Fig. 10, reference numeral 81 is a diversity wireless device of PC card type, and it has a connector 82 for connecting by inserting into a PC card slot not shown. The diversity wireless device 81 is presented for wireless transmission and reception of data as being connected to network connection device such as gateway having PC card slot or portable PC not shown.

[0026]

(Preferred Embodiment 2)

Fig. 2 is a structural diagram of diversity wireless device in a second preferred embodiment of the invention.

[0027]

In Fig. 2, reference numeral 21 is a substrate on which an antenna is mounted. Reference numeral 22 is a ground plane formed on the substrate 21. Reference numeral 23 is a grounded antenna, and numeral 24 is an ungrounded antenna, numerals 23a and 24a are feed terminals, and numeral 23b is a ground terminal for supporting the antenna and connecting the antenna 23 electrically to the ground plane 22. Reference numeral 25 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals. The ground of the RF circuit 25 is connected to the ground plane 22.

[0028]

This embodiment is different from embodiment 1 in that the ungrounded antenna 24 is an antenna having a meandering pattern formed on other substrate.

[0029]

Thus, by using the antennas of different structures, the correlation between the antenna 23 and antenna 24 can be lowered, and the diversity effect making use of merits of both antennas can be obtained. It is also possible to form a meandering

antenna by patterning on the substrate 11.

[0030]

The same effects of the invention are obtained except for the structure of the antenna of the preferred embodiment.

[0031]

(Preferred Embodiment 3)

Fig. 3 is a structural diagram of diversity wireless device in a third preferred embodiment of the invention.

[0032]

In Fig. 3, reference numeral 31 is a substrate on which antennas are mounted. Reference numeral 32 is a ground plane formed on the substrate 31. Reference numeral 33 is a grounded antenna, and numeral 34 is an ungrounded antenna, numeral 33a and 34a are feed terminals, and numerals 33b, 34b are ground terminals for supporting the antennas. In particular, the terminal 33b connects the antenna 33 electrically to the ground plane 32. Reference numeral 35 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals. The ground of the RF circuit 35 is connected to the ground plane 32.

[0033]

In this structure, by defining a specific angle between the grounded antenna 33 and ungrounded antenna 34, the correlation between the antenna 33 and antenna 34 can be lowered, and an effect of polarization diversity is obtained, so that a

diversity wireless device of a large diversity gain is realized.

[0034]

The same effects of the invention are obtained except for the structure of the antennas of the preferred embodiment.

[0035]

(Preferred Embodiment 4)

Fig. 4 is a structural diagram of diversity wireless device in a fourth preferred embodiment of the invention.

[0036]

In Fig. 4, reference numeral 41 is a substrate on which antennas are mounted. Reference numeral 42 is a ground plane formed on the substrate 41. Reference numeral 43 is a grounded antenna, and numeral 44 is an ungrounded antenna, numerals 43a and 44a are feed terminals, and numeral 43b is a ground terminal for supporting the antenna and connecting the antenna 43 electrically to the ground plane 42, and 44b is a support terminal for supporting the antenna.

[0037]

In this embodiment, the ground plane 42 is disposed very closely to the support terminal 44b in order to couple the antenna 44 to the ground at high frequency. Reference numeral 45 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals. The ground of the RF circuit 45 is connected to the ground plane 42.

[0038]

In the structure of this preferred embodiment, by high frequency coupling with the antenna 44 disposed very closely to the ground plane 42, the directivity of the antenna 44 is widened, and the correlation between the antenna 43 and antenna 44 can be lowered, and a diversity wireless device of a large diversity gain is obtained.

[0039]

High frequency coupling of the antenna and ground may be realized not only in the surface layer, but also in the inner layer or reverse side.

[0040]

The same effects of the invention are obtained except for the structure of the antennas of the preferred embodiment.

[0041]

(Preferred Embodiment 5)

Fig. 5 is a structural diagram of diversity wireless device in a fifth preferred embodiment of the invention.

[0042]

In Fig. 5, reference numeral 51 is a substrate on which antennas are mounted. Reference numeral 52 is a ground plane formed on the substrate 51. Reference numerals 53 and 54 are both ungrounded antennas, numerals 53a and 54a are feed terminals, and numerals 53b and 54b are support terminals for supporting the antennas, and the ground plane 52 is disposed

in a close proximity in order to couple with the ground at high frequency.

[0043]

Reference numeral 55 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals.

[0044]

The ground of the RF circuit 55 is connected to the ground plane 52.

[0045]

In the structure of this preferred embodiment, by high frequency coupling with the ground plane 52 disposed in a close proximity to the antennas 53 and 54, the directivity of each antenna is widened, while keeping a low correlation between the antenna 53 and antenna 54, so that an excellent effect of space diversity is obtained.

[0046]

Further, by setting the angle between the two antennas at 90°, signals in a horizontally polarized wave surface are mainly received by one antenna and signals in a vertically polarized wave surface are mainly received by other antenna, so that an effect of polarization diversity is obtained.

[0047]

High frequency coupling of the antennas and ground may be realized not only in the surface layer, but also in the inner

layer or reverse side.

[0048]

The same effects of the invention are obtained except for the structure of the antennas of the preferred embodiment.

[0049]

(Preferred Embodiment 6)

Fig. 6 is a structural diagram of diversity wireless device in a sixth preferred embodiment of the invention, and Fig. 7 is a sectional view of antenna section of the diversity wireless device in the sixth preferred embodiment of the invention.

[0050]

In Fig. 6 and Fig. 7, reference numeral 61 is a multilayer substrate on which antennas are mounted.

[0051]

Reference numeral 62a is a ground plane formed in a first layer of the multilayer substrate 61.

[0052]

Reference numeral 62b is a ground plane formed in a second layer of the multilayer substrate 61.

[0053]

Reference numeral 63 is an ungrounded antenna, which is composed of a feed terminal 63a, a support terminal 63b made of a conductive member, a conductor 63c formed parallel to the multilayer substrate 61, and an insular conductor 63d formed in the first layer of the multilayer substrate 61 and surrounded

by the ground plane 62a.

[0054]

The support terminal 63b connects the conductor 63c and conductor 63d.

[0055]

Reference numeral 64 is an ungrounded antenna, which is composed of a feed terminal 64a, a support terminal 64b made of a conductive member, a conductor 64c formed parallel to the multilayer substrate 61, and an insular conductor 64d formed in the first layer of the multilayer substrate 61 and surrounded by the ground plane 62a.

[0056]

The support terminal 64b connects the conductor 64c and conductor 64d.

[0057]

Reference numeral 65 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals.

[0058]

The ground of the RF circuit 65, and the ground planes 62a, 62b are connected directly or by way of through-holes.

[0059]

In this structure, since the conductors 63d, 64d, as part of antenna, are coupled with the ground planes 62a, 62b at high frequency, the directivity of each antenna is widened, while

keeping a low correlation between the two antennas, so that an excellent effect of space diversity is obtained.

[0060]

Further, by setting the angle between the two antennas at 90°, signals in a horizontally polarized wave surface are mainly received by one antenna and signals in a vertically polarized wave surface are mainly received by other antenna, so that an effect of polarization diversity is also obtained.

[0061]

The same effects of the invention are obtained except for the structure of the antennas of the preferred embodiment.

[0062]

In this preferred embodiment, for example, the conductors 63c, 63d are formed parallel to the multilayer substrate 61, but the shape is not particularly limited.

[0063]

The conductors 63d, 64d are not required to be formed on the multilayer substrate 61, but may be also formed at the antenna side.

[0064]

Both antennas 63 and 64 are not grounded, but only one antenna may be an ungrounded one.

[0065]

(Preferred Embodiment 7)

Fig. 8 is a structural diagram of diversity wireless device

in a seventh preferred embodiment of the invention, and Fig. 9 is a sectional view of antenna section of the diversity wireless device in the seventh preferred embodiment of the invention.

[0066]

In Fig. 8 and Fig. 9, reference numeral 71 is a multilayer substrate on which antennas are mounted.

[0067]

Reference numeral 72a is a ground plane formed in a first layer of the multilayer substrate 71.

[0068]

Reference numeral 72b is a ground plane formed in a second layer of the multilayer substrate 71.

[0069]

Reference numeral 72c is a ground plane formed in a third layer of the multilayer substrate 71.

[0070]

Reference numeral 73 is an ungrounded antenna, which is composed of a feed terminal 73a, a support terminal 73b made of a conductive member, a conductor 73c formed parallel to the multilayer substrate 71, and an insular conductor 73d formed in the second layer of the multilayer substrate 71 and surrounded by the ground plane 72b.

[0071]

The conductor 73d is surrounded by the ground planes 72a,

72b, 72c three-dimensionally.

[0072]

The support terminal 73b connects the conductor 73c and conductor 73d.

[0073]

Reference numeral 74 is an ungrounded antenna, which is composed of a feed terminal 74a, a support terminal 74b made of a conductive member, a conductor 74c formed parallel to the multilayer substrate 71, and an insular conductor 74d formed in the second layer of the multilayer substrate 71 and surrounded by the ground plane 72b.

[0074]

The conductor 74d is surrounded by the ground planes 72a, 72b, 72c three-dimensionally.

[0075]

The support terminal 74b connects the conductor 74c and conductor 74d.

[0076]

Reference numeral 75 is an RF circuit, which switches the transmission and reception antennas, feeds power to the antennas, and processes received signals.

[0077]

The ground of the RF circuit 75, and the ground planes 72a, 72b, 72c are connected directly or by way of through-holes.

[0078]

In this structure, since the conductors 73d, 74d, as part of antenna, are coupled with the ground planes 72a, 72b, 72c at high frequency, the directivity of each antenna is widened, while keeping a low correlation between the two antennas, so that an excellent effect of space diversity is obtained.

[0079]

Further, by setting the angle between the two antennas at 90°, signals in a horizontally polarized wave surface are mainly received by one antenna and signals in a vertically polarized wave surface are mainly received by other antenna, so that an effect of polarization diversity is also obtained.

[0080]

The same effects of the invention are obtained except for the structure of the antennas of the preferred embodiment.

[0081]

In this preferred embodiment, for example, the conductors 73c, 74c are formed parallel to the multilayer substrate 71, but the shape is not particularly limited.

[0082]

The conductors 73d, 74d may be formed in the lowest layer, and a ground plane may be disposed on its higher layer, and may be coupled at high frequency.

[0083]

Both antennas 73 and 74 are not grounded, but only one antenna may be an ungrounded one.

[0084]

[Advantage of the Invention]

According to the invention, at least one of the plurality of the antennas of the diversity wireless device is not grounded, and therefore the correlation between the antennas can be lowered, so that a high diversity gain may be obtained.

[Brief Description of the Drawings]

Fig. 1 is a structural diagram of diversity wireless device in a first preferred embodiment of the invention.

Fig. 2 is a structural diagram of diversity wireless device in a second preferred embodiment of the invention.

Fig. 3 is a structural diagram of diversity wireless device in a third preferred embodiment of the invention.

Fig. 4 is a structural diagram of diversity wireless device in a fourth preferred embodiment of the invention.

Fig. 5 is a structural diagram of diversity wireless device in a fifth preferred embodiment of the invention.

Fig. 6 is a structural diagram of diversity wireless device in a sixth preferred embodiment of the invention.

Fig. 7 is a sectional view of antenna section of diversity wireless device in the sixth preferred embodiment of the invention.

Fig. 8 is a structural diagram of diversity wireless device in a seventh preferred embodiment of the invention.

Fig. 9 is a sectional view of antenna section of diversity

wireless device in the seventh preferred embodiment of the invention.

Fig. 10 is an appearance diagram of the diversity wireless device in the first preferred embodiment of the invention.

Fig. 11 is a structural diagram of a conventional diversity wireless device.

[Description of the Reference Numerals]

11 Substrate

12 Ground plane

13 Grounded antenna

13a Feed terminal of antenna

13b Ground terminal of antenna

14 Ungrounded antenna

14a Feed terminal of antenna

14b Support terminal of antenna

15 RF circuit

[Name of the Document] Abstract

[Abstract]

[Object] To present a diversity wireless device reduced in size without lowering the diversity gain.

[Means to Solve the Problems] At least one of the plurality of antennas of a diversity wireless device is not grounded, and therefore the correlation between the antennas is lowered, and a high diversity gain is obtained.

[Selected Drawing] Fig. 1

[Name of the document] Drawing

Fig. 1

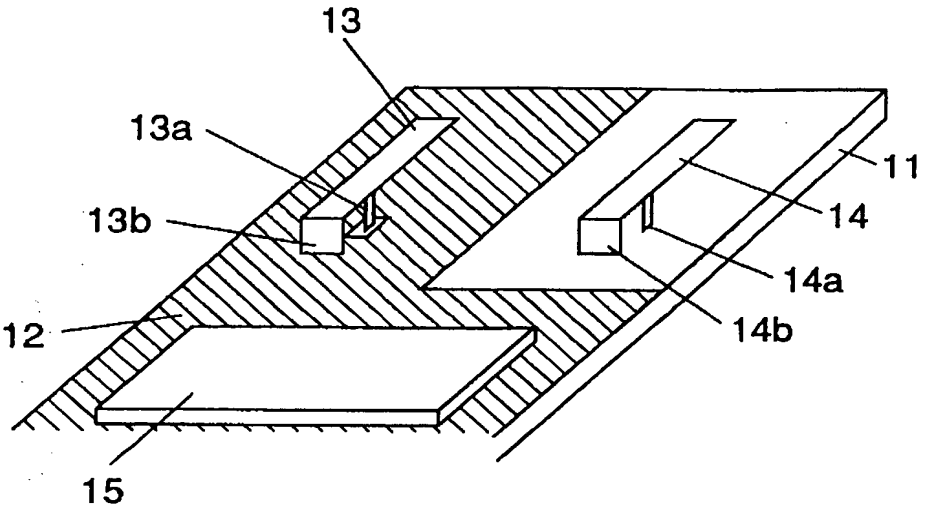

Fig. 2

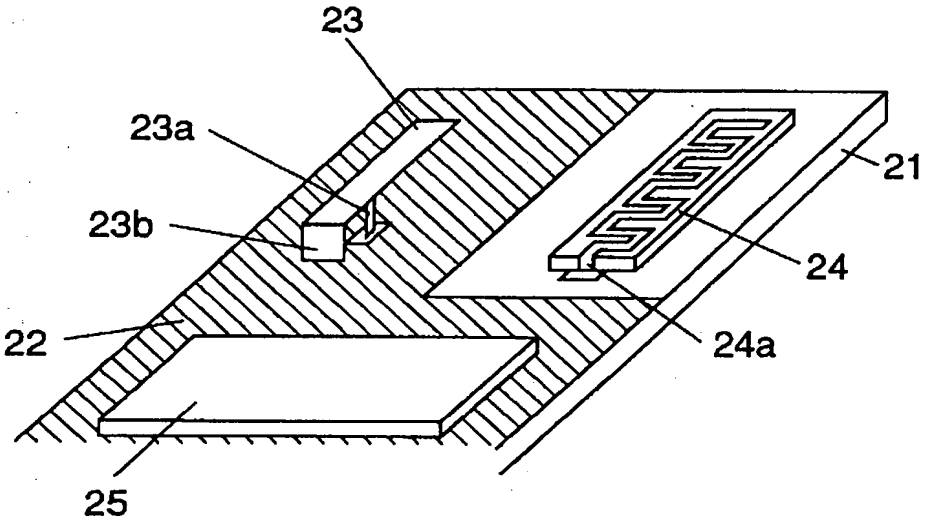

Fig. 3

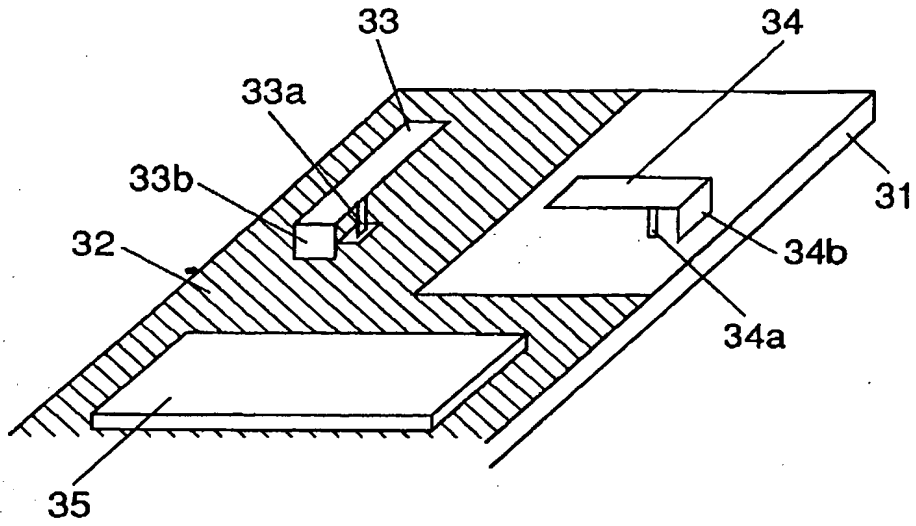

Fig. 4

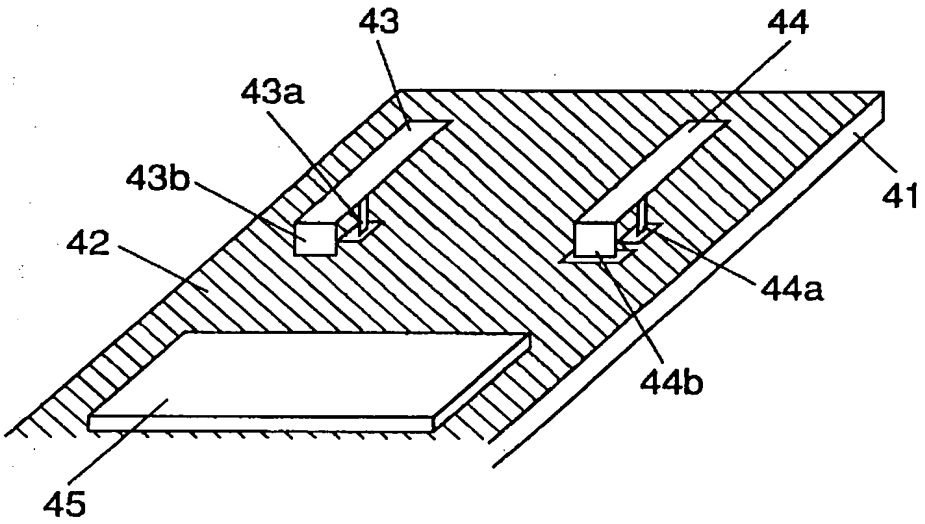

Fig. 5

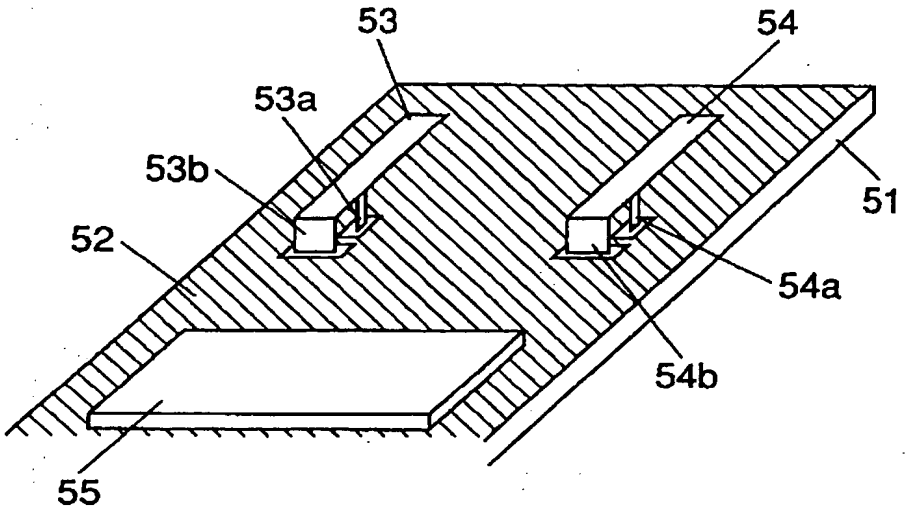

Fig. 6

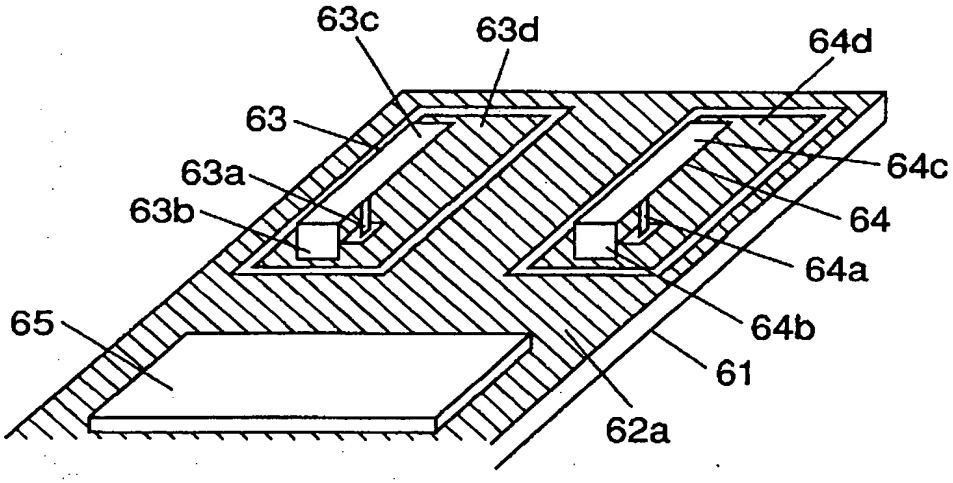

Fig. 7

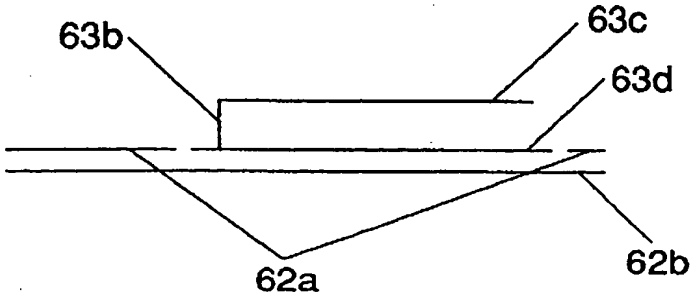

Fig. 8

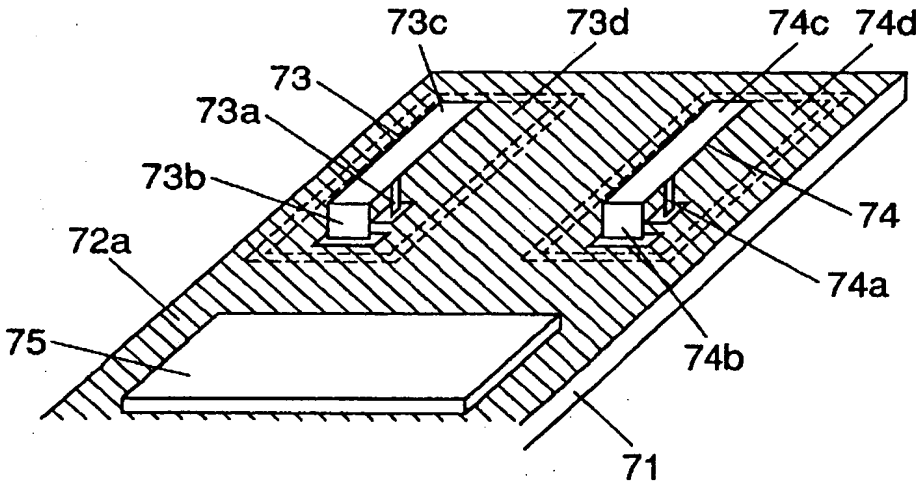

Fig. 9

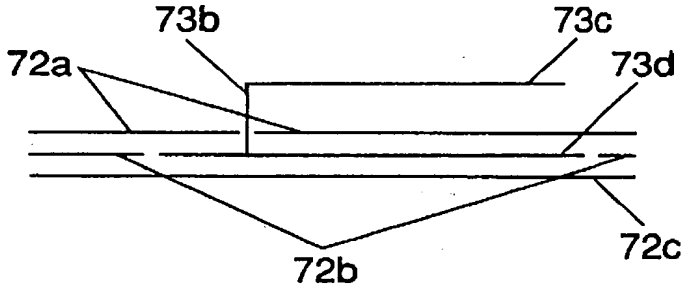

Fig. 10

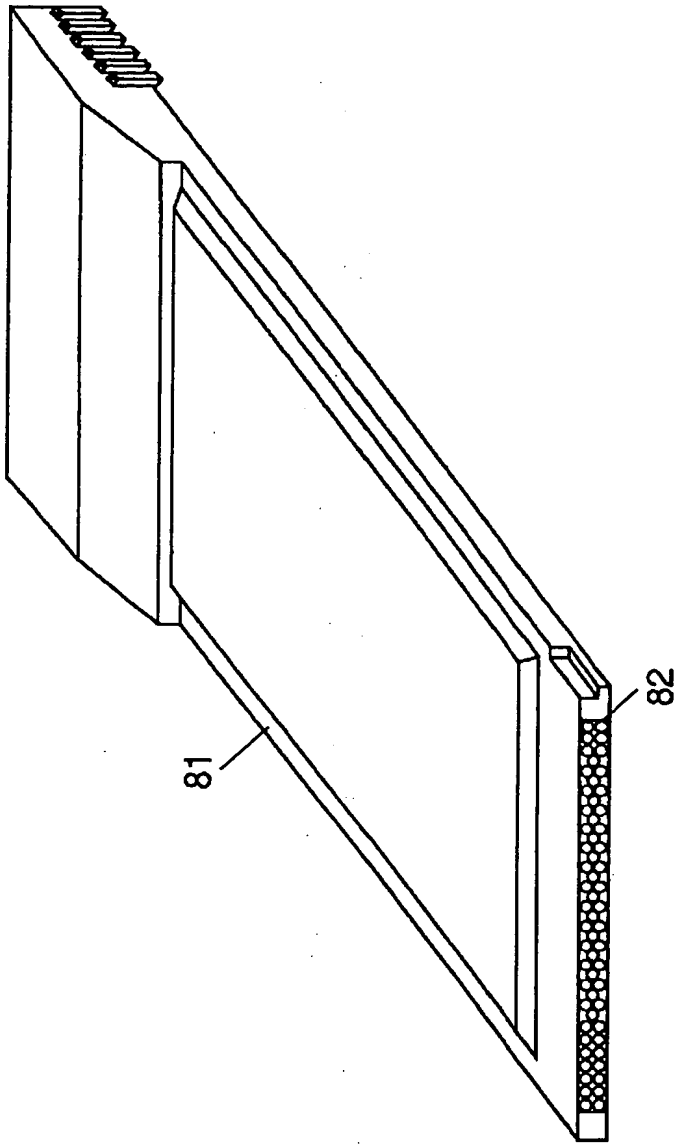

Fig. 11